PROPERTY OF
PENNA. STATE LIBRARY

BULLETIN No. 4

COMMONWEALTH OF PENNSYLVANIA

BOARD OF FISH COMMISSIONERS

A Treatise on the Fish of Pennsylvania

By

C. R. Buller

Deputy Commissioner of Fisheries

Harrisburg, Pennsylvania

1927

P38.31
1.5

Digitized by the Internet Archive
in 2016

https://archive.org/details/treatiseonfishof00bull

COMMONWEALTH OF PENNSYLVANIA

BOARD OF FISH COMMISSIONERS

NATHAN R. BULLER
Commissioner of Fisheries

C. R. BULLER
Deputy Commissioner of Fisheries
Pleasant Mount, Wayne County

MEMBERS — BOARD OF FISH COMMISSIONERS

N. R. Buller, Chairman
John Hamberger, Erie
M. A. Riley, Ellwood City
Charles Reitell, Pittsburgh
T. H. Harter, Bellefonte
Dan R. Schnabel, Johnstown
Leslie W. Seylar, McConnellsburg
William Mann Irvine, Mercersburg
H. R. Stackhouse, Secretary to Board

COMMONWEALTH OF PENNSYLVANIA

BOARD OF FISH COMMISSIONERS

A Treatise on the Fish of Pennsylvania

By

C. R. BULLER

Deputy Commissioner of Fisheries

FRONTISPIECE

BIGELOW LAKE, Wayne County, Pennsylvania.
One of the Small Glacial Lakes of Pennsylvania.

INTRODUCTION

Charles W. Eliot, President Emeritus, Harvard University, said: "The organized summer camp is the most important step in education that America has given to the world."

Pennsylvania, particularly the northeastern section, is dotted by many small glacial lakes. These small natural lakes, with a background of beautifully wooded mountain scenery, have attracted many camp organizers, and today numerous camps of modern construction have been established. During the summer months, the youngsters staying at these camps spend much of their time angling for the sunfish, the yellow perch, the catfish, and perhaps for the higher finny game, as the pike or the bass. Here probably starts the train of thought that leads to many of the perplexing questions in regard to fish life that are asked the teacher when the school term opens.

One simple question asked by the youthful angler often-times leads to a general discussion on fish and fish life, and the Commissioner of Fisheries is usually consulted in order to decide the issue. These general discussions cannot help but be of educational value to Pennsylvania's future anglers.

The following is not a scientific treatise on fish, but was written with the hope that it would be comprehensive to the average eighth grade pupil, and would eliminate the necessity of the Commissioner of Fisheries answering each question by an individual letter. In compiling the following, I have freely consulted works by such authorities as Dr. Jordan, Dr. Everman, Dr. Kendall, and others.

The Board of Fish Commissioners realize that much can be done by education to help maintain fishing in Pennsylvania, and the place to start this education is in the public schools, and the summer camps. To assist in this educational work, they have established at several of the major hatcheries aquariums where many kinds of fish, turtles, frogs, and other aquatic life are maintained for the benefit of those interested in nature studies. A description of the life maintained in one of these hatchery aquariums is given in detail in Bulletin No. 3. They have created moving

pictures portraying the life history and the propagation of a number of species of fish, which can be obtained by making requisition to the Board of Fish Commissioners, Harrisburg, Pennsylvania.

They have men trained in such a manner that their talks are comprehensive to the school children to talk on fish and fish culture. Public schools are furnished various species of fish, together with vials containing fish eggs in their various stages of development. Bulletins are also sent upon request. Pupils living in the rural districts are reached more effectively by bulletins than in any other way, as where the attendance is small it does not warrant the Board to send men and pictures.

C. R. B.

GENERAL CHARACTERISTICS

Definition of a Fish: Dr. Jordan's definition of a fish is: "A fish is a back-boned animal which lives in the water and cannot ever live very long anywhere else. Its ancestors have always dwelt in water, and most likely its descendents will forever follow their example. So, as the water is a region very different from the fields or the woods, a fish in form and structure must be quite unlike all the beasts and birds that walk or creep or fly above ground, breathing air and being fitted to live in it. There are a great many kinds of animals called fishes, but in this all of them agree: All have sort of a back-bone, all of them breathe their life long by means of gills, and none have fingers or toes with which to creep about on land."

Where Found: Fish are found living under all sorts of conditions; some are adapted for life in the frigid zone, where the weather is extremely cold; others in the temperate zone, where they must be capable of withstanding the cold water during the winter and warmer water during the summer. Others are of the torrid zone, or very warm climate. Without regard to climate, some fish are adapted for a life in the salt water of the ocean; others live in the fresh water of our streams, lakes, and rivers. Some live part of the time in salt water and part of the time in fresh water, usually migrating at the approach of spawning season from fresh to salt water, or vice versa; still others make their home in brackish water; that is, where the salt water mingles with the fresh water at the mouths of the stream.

While this bulletin deals only with Pennsylvania fishes, fortunately, we have two direct outlets for the fishes to salt water; the Susquehanna River and the Delaware River where the migration of several species takes place. Fish whose real home is in the ocean but enter fresh water to spawn or reproduce are called Anadromous fish. An example of one of the fish of Pennsylvania of this type is the shad. At the approach of egg-laying time, which is in the early spring, the fish leave their salt water homes and migrate long

distances up the river. The eggs are deposited, and when hatched, the young soon migrate down the river to their real home in the ocean.

Fish that leave their fresh water homes and enter the ocean for the purpose of reproduction are called Catadromous fish. The only one of the fish of Pennsylvania having this instinct, that I can recall, is the eel. The downward migration of the parent eel is in the fall of the year, and the upward run of the young seeking their fresh water homes takes place in the spring.

Forms of the Fish: The forms or shapes of fish depend a great deal upon where they live and how they feed. The water offers considerable resistance to their movements, so they are generally built to move through the water with the least resistance. Fish depending upon speed and strength for securing their food and escaping their enemies, are built for speed and strength. They have cylindrical bodies with much fin development; for an example, pickerel. Other fish of the same type of body, but of small fin development, seek their food by crawling on the bottom of the stream, and protect themselves by entering cracks or crevices in rocks, as the eel. Other fish are somewhat flattened, with the body tapering toward each end, and are covered with plates or scales. Fish of this type depend to a certain degree on their armor plate, or scales, and on their color for protection. The protective coloring usually blends with the aquatic plants, or the pond bottoms, making it difficult for an enemy to see the fish. While this affords them protection, it also enables them to approach their prey or food without being seen. A fair example of a fish of this type is the yellow perch.

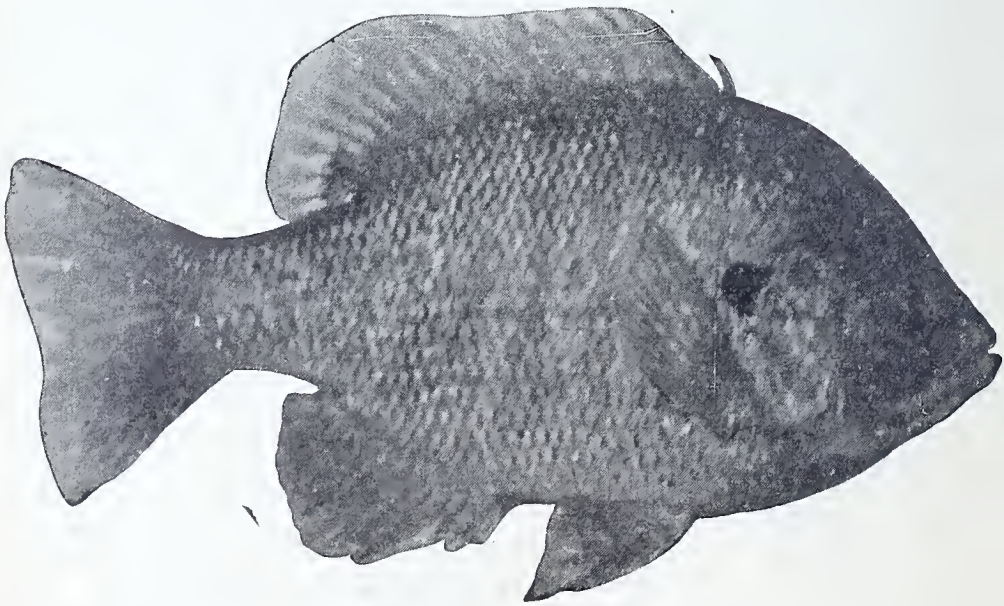
The sunfish, an inhabitant of the still waters and the lakes of Pennsylvania, with its much compressed body tapering abruptly at both ends, would have little chance of fighting the swift water of our mountain streams in which the brook trout live. The sunfish, with its keel-like body, cannot keep its balance in the swift running streams, while the trout built on entirely different lines, can readily fight the current. The difference in form of the trout and the sunfish can be seen by comparing the cuts.

Fish vary in structure according to their feeding habits. Perhaps the mouth varies more with respect to feeding habits than do any

other of its external structures; its variance in size, shape, and position depending much upon the food consumed. Fish that depend principally upon other fish for food have exceptionally large mouths armed with numerous long, hook-shaped teeth used for seizing and holding their prey. Examples of fish of this type are the pike perch, and the pickerel.

Sunfish have comparatively small mouths armed with teeth that enable them to crush the shells of small snails, or other crustaceous creatures. Again, if we look at the sucker, which is a bottom feeder, we will find that his mouth is located where it can be used to the best advantage. It opens downward and can be thrust forward and drawn back at will.

The bullhead generally feeds at night or among the roily water of the bottom. His large mouth enables him to pick up choice morsels with little difficulty; his eyes are small compared with other fish, as he probably sees little while feeding but depends on his sense of smell and on his whisker-like barbels which are filled with many sense cells of feeling.



BLUEGILL SUNFISH

One of the spiny-rayed fish of Pennsylvania, having one long, continuous dorsal fin. The sides of this fish are greatly compressed, and taper abruptly at both ends. This species inhabit our lakes and our rivers; is of the nest building variety, and defends its home with much vigor.

Surface Covering of the Fish: The exterior of the fish is covered by a slippery mucous commonly called slime. This slimy covering has many uses: it enables the fish to pass through the water with less resistance than if its exterior were of a less slippery nature. It affords protection from the enemy, as, when grasped, it is held with difficulty. This mucous is also a protection against disease.

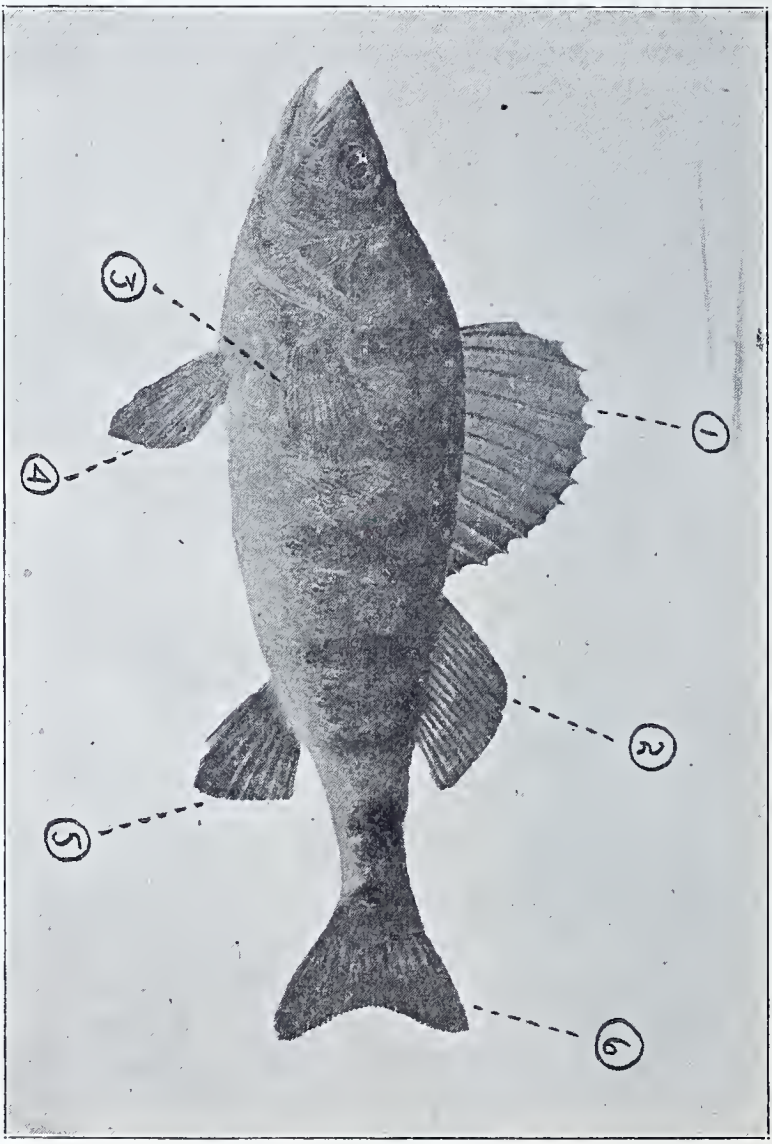
Fish, like higher forms of animal life, are subject to disease, one of the most common fish diseases being fungus. A white, hairy growth attacks the fish on the part of the body where the slime has been removed. This gradually spreads over the body of the fish, generally resulting in its death. One way of removing the slime is to touch the fish with a dry object. Therefore, let us all remember the next time we are fishing and we catch a small fish which we wish to return to the water without injury, to be sure to wet our hands before touching the fish.

Under this outside slimy coat can be found the real covering of the fish. The coverings are of three different characters; the armor plate, which consists of diagonal whorls of solid plates of bone, each divided into scale-like sections, and so hinged together that while the whole fish is fully protected, it has freedom of movement. These fish, called Ganoids, lived many thousand years ago in what geology called the Devonian Age, or Age of Fishes, and we are led to believe that these armor-clad creatures were the beginning of our modern forms of fish. Some of these curious fish still exist in what is believed to be almost the original form. Two of these are found in Pennsylvania, the gar pike and the sturgeon. Their survival through the many ages is probably due to this armor cover.

The naked covering, or that free from plates or scales, consists of a tough skin, such as that found on the eel and the bullhead. The scale variety, which is the covering for the majority of the fish of Pennsylvania is composed of a hard substance, one scale overlapping the other, much as shingles do on the roof of a house. Examples of the true scaled type of fish can be found in the yellow perch, the black bass, and the sunfish.

Air Bladder: It is not my intention to take up the functions of all the internal organs of the fish, but when cleaning the day's catch, our youthful anglers could hardly miss seeing the air or

swim bladder. The various functions of the air bladder have been the subject of much discussion among scientists. Perhaps its chief function is to regulate the specific gravity of the fish, or in other



THE YELLOW PERCH

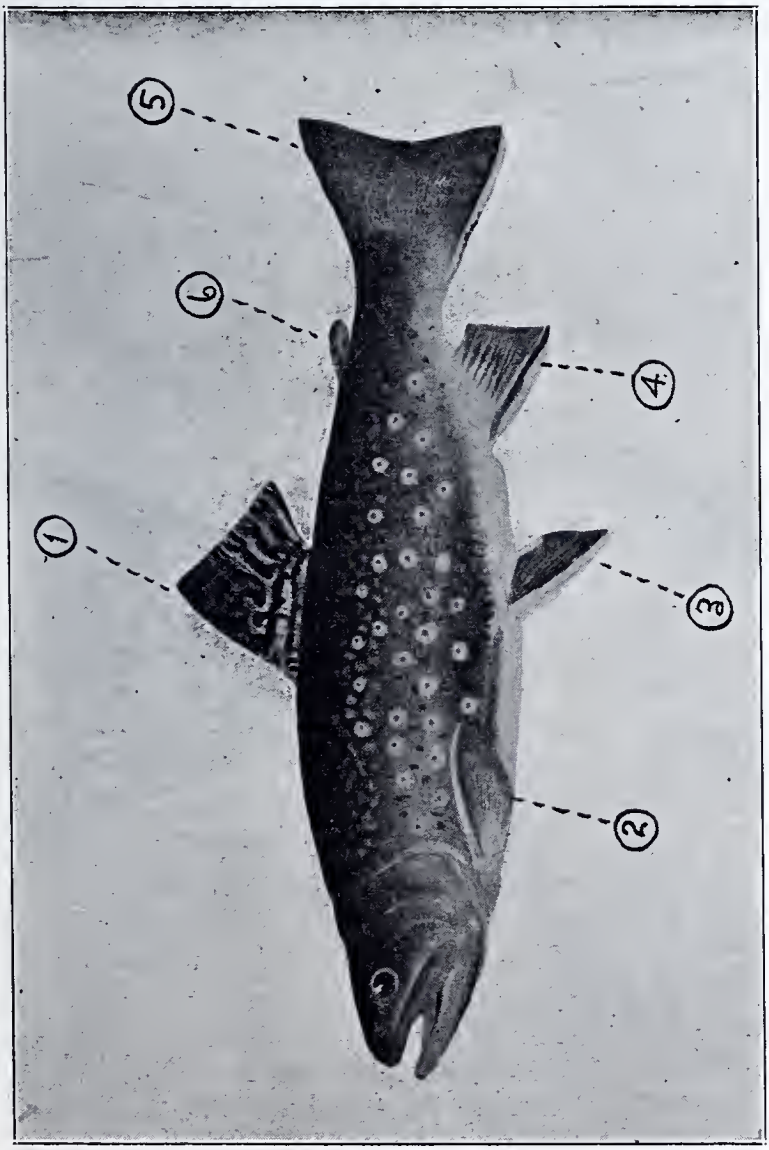
The Yellow Perch is a spiny-rayed fish, with two dorsal fins. One, the Anterior, composed of spiny rays, and the other, the Posterior, composed of soft rays. The body covering is of heavy scales, placed one upon the other, as shingles are on the roof of a house.

1. First or Anterior Dorsal Fin
2. Second or Posterior Dorsal Fin
3. Pectoral Fins, two in number
4. Ventral Fins, two in number
5. Anal Fin
6. Caudal or Tail Fin

words, to adjust the equilibrium of the fish in water. When empty, it increases the weight of the fish; and when full or inflated, decreases its weight. Oftentimes fish can be seen to lie almost motion-

less in the water. They are able to do this, probably, because of the power of inflation of the air bladder.

FINS OF THE FISH: The fins are structures protruding from the body of the fish. They are made of rods or rays joined together by membranes. There are two kinds of rays or rods; one



BROOK TROUT

A soft-rayed fish of our cool mountain streams, having one dorsal fin, and an adipose fin present.

1. Dorsal Fin
2. Pectoral Fins, two in number
3. Ventral Fins, two in number
4. Anal Fin
5. Caudal or Tail Fin
6. Adipose Fin

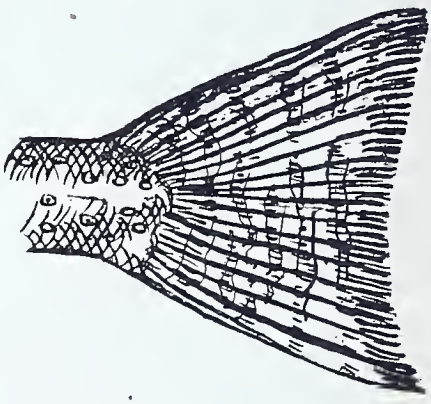
is without joints and tapers to sharp points. These rods are known as spines. There are not many people who are interested in fish and

fishing who have not been cut by the spines on the yellow perch or sunfish. The other kind is made up of many little joints which are known as soft rays. These soft rays are found in the brook trout.

Because of this fin construction, fish are divided into two classes: Those having the stiff rods or spines on the fins are known as spiny-rayed fishes, and those having the soft rays are known as soft-rayed fishes. Examples of these two types of fish can be seen by referring to the cuts of the yellow perch and the trout.

The shape and the position of the fins vary greatly in different species of fish. Space wili not permit going into detail regarding these differences; but, as an example, let us take the tail fin of the trout and the sturgeon. In the trout this fin terminates very nearly square, and is adapted for swimming straight through the water; while in the sturgeon this fin is longer above than below, and this construction has a tendency to force the body downward to the bottom where this particular fish obtains most of its food.

TAIL OF THE STURGEON



TAIL OF THE TROUT

The fins are named according to their location on the body of the fish. Some fins are paired and others are single. The paired fins will be taken up first, because they can be likened to the four legs of a higher animal.

The pectoral fins, two in number, are those situated in the place where the front legs of a higher animal are found. The ventral fins, two in number, are situated somewhat near the place where the hind legs of an animal are found. The dorsal fin is found on the back

of the fish. Some species have two dorsals, as can be seen in the cut of the yellow perch; while other fish have but a single dorsal, as the trout.

The single fin situated behind the ventral fin and near the anus is the anal fin. The tail of the fish is called the caudal fin. In some fish, as the brook trout and the bullhead, a small fin is found between the dorsal fin and the caudal fin called the adipose fin. In examining the fins of fish, care must be taken not to confuse the adipose with the two dorsals found on some fish. The adipose fin is usually very small and contains no rays.

SENSES: Fish possess all five senses, but the sense organs differ somewhat from those of land animals and some of them are not so well developed.

Sight: The eyes are without lids, since the water keeps the eyeballs moist and free from foreign matter. If fish go to sleep, it must be with the eyes wide open. The pupils are generally large in comparison with those of land animals. This is necessary under water where the light is not strong.

Hearing: The ear of the fish does not protrude from the head as does the ear of higher animals, but is in the form of a hidden ear enclosed in membrane; probably the water sends the sound wave or vibration directly to this drum. Just how well the sense of hearing of fish is developed is not clearly understood, but I am led to believe that unless sound is produced in such a way as to produce vibration in the water, fish cannot hear. Thus sound waves produced by the human voice on the shores of a pond are not heard by the fish, but if two stones are bumped together under the water, the sound produced can be heard by the fish.

Smell: The nostrils are two small membranous sacks connected with the water by two small openings. Inside of these membranous sacks are many sense cells of smell. As with land animals, the sense of smell varies greatly with different species. The bullhead that feeds on the bottom in roily waters, probably, has a much keener scent than the pickerel that feeds in shallow water during the early morning when light penetrates the water.

Taste: Because fish swallow their food whole or in large pieces, one would assume that the sense of taste in fish is not very well developed; but from observation of fish being fed at the hatcheries,

one is led to believe the contrary, as a fish seizing food that is spoiled or is not to his liking can readily be seen spitting it out.

Touch: The entire skin of the fish is provided with touch sense cells. On some portions of the body they are more developed than others. Some fish, such as the bullhead, are provided with barbels or feelers, and the sense of touch is very well developed in these organs, as they are probably used to assist the fish in finding his way near the pond bottom in roily water.

Respiration: The respiration of land animals is the breathing of air into the lungs for the purpose of purifying the blood. In fish, respiration is the breathing of water over the gills for the same purpose. Fish breathe water instead of air, and the exchange of gases takes place in the gills, and not in lungs, as in the case with land animals. The gills are supported by gill arches, each gill bearing rows of gill fringes somewhat resembling red fringe. These fringes are full of small capillaries or blood vessels. The blood is brought from the heart to the gill fringes where the exchange of gases takes place. The impure gases contained in the blood pass out and the oxygen is taken in from the continuous stream of water which enters through the mouth and bathes the gill fringes on its way out through the gill slits. Because of this exchange of gases taking place in the gills, if the fish are not supplied with fresh water, they soon suffocate.

In some fish the pectoral fins can rightly be classed as an auxiliary respiratory organ. Their constant motion, when the fish is apparently motionless in still water, keeps a supply of fresh water moving in and about the mouth and the gills. This function of the pectoral fins can plainly be seen by observing a common gold fish in an aquarium. Many times the gold fish lie in one place for hours. In the still water aquariums there is very little, if any, water circulation. Were it not for the constant motion of these fins, the oxygen in the water around the mouth and the gills would soon be consumed.

How Fish Swim: If our ancestors could have seen a modern submarine rise to the surface, turn around, submerge, and rapidly move away, they would probably have thought it alive and called it a great fish. We realize that the submarine is only a piece of modern machinery. Now let us look at a fish moving through the water and picture it also as a machine. In this living machine the hull of the

ship is made up of the skeleton comprising the backbone and the tiny ribs, and is covered with the outer layer of scales, skin, or plates, as the case may be. The skull, coupled to the backbone in a rigid manner so that it can resist the forward thrust of the backbone without greatly varying its position, can be likened to the bow of the ship.

Inside of this hull are many complex parts used in keeping the ship in perfect condition, and for generating energy for locomotion. The digestive tracts, assisted by the circulation, are the huge boilers. The fuel taken in through the mouth in the form of food, is burned up or consumed in these boilers and is generated into energy. A portion of this energy is used in swimming or moving from place to place. The backbone, composed of a number of tiny vertebrae, can be likened to the propellor shaft, because at the end of this shaft is the tail or caudal fin used chiefly in the forward motion of the craft. In the bow of the ship, or the skull of the fish, is really the captain's cabin, because at this point many of the vital organs for controlling this live ship are found, including the sense organs which may be likened to our nose, our eyes, our ears, and the balancing organs. The most vital organ for controlling this ship is the brain, because from the brain to every part of the fish are lines of communication in the form of nerve cells, over which are transmitted the orders regulating the different functions of the fins, the body, etc. But in order to understand more fully how this submarine craft is handled, we shall take up each subject separately.

Locomotion: The chief propelling power in most fish is the tail or caudal fin, assisted by the body movement. When the fish moves forward, the tail is lashed from side to side, much in the same manner as an oar is used in sculling a boat. Generally, in the rapid forward movement other fins are drawn in against the body in order to lessen the resistance. However, when moving at a very slow speed, the tail fin is assisted by the pectoral fins. Oftentimes fish approach an object, and from fear, or some other cause, back slowly away. In this backward movement the pectoral fins do most of the work.

Most of us are familiar with the rapidity with which fish can swim among rocks, brush, stumps, etc. Nature has provided them with a wonderful stopping or breaking device to avoid injury by

colliding with foreign objects. This efficient breaking system is very noticeable in the chain pickerel; the paired fins are spread and rigidly set. The caudal fin takes the reverse action of that used in the forward movement.

Steering: The tail fin, assisted by the body movement, is probably the chief steering device of the fish when it is moving through the water on a level plane. When it wishes to change its plane for a higher or lower level, the paired fins are used much as are the wings of a submarine or an airship. Probably here also comes into play the air bladder.

Balancing: Fish, like the sunfish, with their compressed sides, have more difficulty in keeping their balance than do the pike or the pickerel with their more or less spindled-shaped bodies. Without regard to the shape of the body, all the fins assist in balancing, but when not in motion the paired fins probably play the most important part.

Reproductions: The normal fish of Pennsylvania reproduce by laying eggs, the eggs being deposited by the female. The milt or sperm is poured over them by the male. This process of depositing the eggs and their external fertilization by the sperm of the male is known as spawning. The fish that are common in our waters spawn but once a year. Fish of one species or another are spawning in almost every month of the year; for instance, the brook trout spawn any time between October fifteenth and December thirtieth; black bass in May or June; yellow perch and pike perch in April and May. The size and the number of eggs laid by a female depend upon the kind of fish or species, and age and size of the individual. As an illustration, a brook trout may deposit from two hundred and fifty to two thousand eggs, with a count of approximately thirteen thousand to the quart. A pike perch may produce from fifteen thousand to thirty-five thousand eggs and a count of seventy-five thousand to one hundred thousand to the quart.

The eggs deposited by the different species of fish vary greatly in appearance; some come forth singly and are covered by a sticky mucous. These eggs are called adhesive and they attach themselves to the clean rocks of the fish's nests, if the fish are nest builders, or to aquatic plants, roots, or sunken logs, and other ma-

terials, if they are not nest builders. The eggs of the sunfish and of the golden shiner are the adhesive type. Eggs that come forth singly and do not have this adhesive quality are called non-adhesive eggs. The eggs of the brook trout and the brown trout are non-adhesive. Others come forth surrounded and held together by a gelatinous mass, like the eggs of the bullhead and the yellow perch.

Some fish during spawning deposit their eggs by scattering them broadcast on the bottom; examples, suckers and pike perch. Other kinds, as the trout, build nests or homes into which they deposit their eggs, and when this is done, they desert their homes and let nature do the rest. Fish, whose eggs come forth in veil-like ribbons, like the yellow perch, deposit their eggs on submerged brush, water plants, old logs, or on anything that will keep them from settling to the bottom, where they would be smothered by sediment; and then the fish leave the eggs to their fate.

Some kinds of fish are endowed with a wonderful parental instinct. They build a nest or home, deposit their eggs therein and protect and care for the eggs and young fish until such time as each little fish is able to go its way. Of the fish with which I am familiar, I think the parental instinct of the common bullhead is most interesting; therefore, I am going to tell you of the home life of these blundering chaps.

In Pennsylvania the bullhead spawns in the month of June. Unlike the male bass, who prepares the nest and then goes forth to entice a female to enter the home, the bullhead does the courting before the home is chosen; and the bride, so to speak, helps to build the home. As spawning time approaches, the fish pair off and move about along the shore line, seeking a suitable place to build the nest. Unless an abandoned muskrat hole or some similar excavation is found, the home building will be a long and trying task.

When a ready-built home is not found, the home usually consists of a hole dug in the clay bottom, about six inches in diameter, and from twelve to twenty-four inches deep. It usually takes from five to six days to complete the nest. The excavation is made with the sharp spines of the fins. The light sediment is washed

out by the fin and the tail motion, and the heavier material is removed with the mouth. During the home building, the water in the vicinity is kept roily by their work.

After the home is completed, the eggs are deposited therein. They are not extruded singly, as are the pike and the trout eggs, but in a jelly-like ball, averaging about three and one-half inches in diameter when fully expanded, and containing from fifteen hundred to two thousand eggs. The eggs are of a rich amber color.

While the male parent may be a little severe in insisting that his mate help to prepare the home, once the home ties are established in the way of the little round ball of eggs, he is constantly assisting the mother to care for the eggs and the baby fish. The period of incubation is from ten to twenty days, and during this period either or both of the parent fish are constantly guarding the nest from invasion by other fish, snakes, turtles, etc., bent upon devouring the eggs. They are well able to protect their home, as in and about their home they are a blood thirsty and bullying set, with ever a lance at hand, ready to battle with an intruder at a minute's notice.

Just why the bullhead in the inland waters goes to all the trouble to prepare the hole in the earth for a home for the eggs and young fish, I am unable to say, unless it is for added protection. And again it may be from instinct. Many of the common bullheads inhabit the tidal waters of the Delaware River. At spawning time they seek the low marshy swamps on which to build the nest or hole. As the tide recedes, leaving the marshes dry, the parent fish, or the young, as the case may be, enter the hole when the tide goes out. The hole contains sufficient water for their needs until the tide comes in again. After the spawning season, the hole is abandoned, and the fish more or less follow the rise and fall of the tide. This instinct for protection from the receding tide may remain in the catfish of the inland waters.

During the period of incubation, owing to the poor circulation of the water in the hole, the parent fish are constantly keeping up a fin motion over and above the eggs, thus insuring aeration of the water. From time to time, the position of the ball of eggs is changed, usually by rolling it over with their snouts, but if the

hole contains too much sediment to roll the eggs, the eggs are taken in the mouth by the parent fish and are blown out again. In this way they give it a new position on top of the sediment.

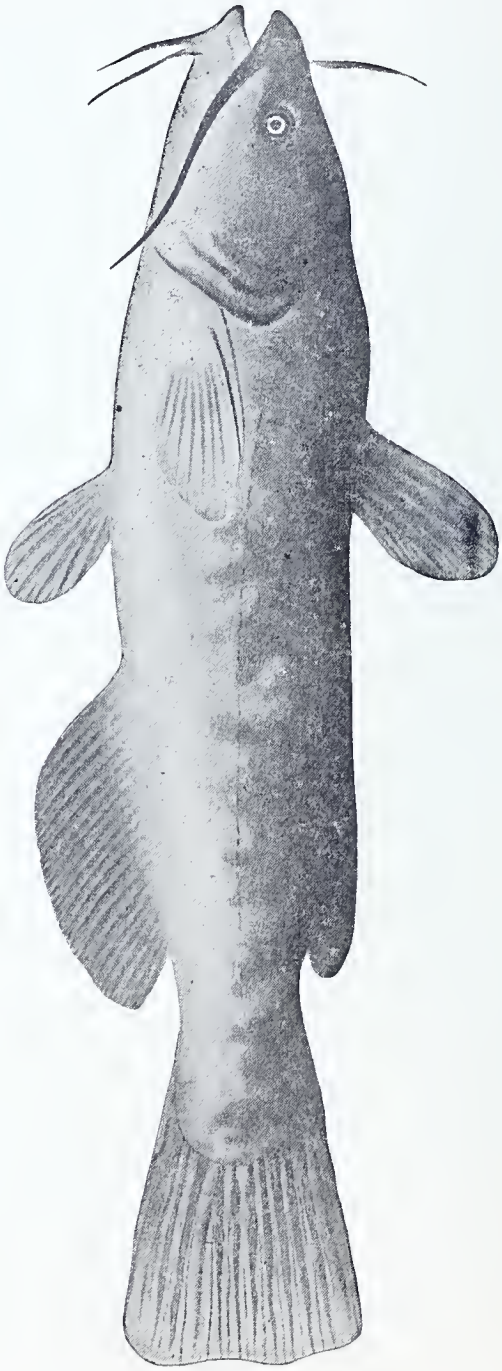
When the baby fish first break from the shell, they are very weak and helpless creatures, of a pale salmon color. Attached to the lower portion of the body of each baby fish is a yolk bag or food sac. This sac contains nourishment for the baby fish for the first five or ten days of its life. During this period of the baby fish's life, the parent fish will not permit them to leave the home. They keep a constant supply of water moving over them by the motion of the fins. If one tiny fellow, more venturesome than its brothers and its sisters, strays from the group, the parent fish sucks it up in his or her mouth and blows it back among the school. Perhaps for the first offense it is not blown very hard, but the second time it will learn to respect the authority of the father and the mother.

As the food sac is gradually absorbed, the little fish take on a darker color. After the sac is entirely absorbed, the little fish must have food. At this time the parent fish bring them in a school from the hole, and coax them along in search of food, which will consist of very tiny insects found on the bottom in the shallow water. Much as an old hen broods over her little chicks, either or both parents guard constantly the well-being of the baby fish.

After the babies little stomachs are filled, the parents will bask in the sun being entirely surrounded by the school of baby fish. If an enemy approaches, by a quick motion of the body and the fins of the parent fish, the water surrounding the baby fish is roiled. The babies then quickly settle in the roily water to the bottom of the lake out of the way of harm, the parents seeking protection in the deeper water. When the enemy, bewildered by the roily water, moves away, the school is again collected by the parent fish.

For the first few days, the school is not taken far from the home, but each day as the youngsters become stronger, they increase their range in search of food, returning home every evening. As the little fish gain in strength and confidence, they roam short distances from the parents, seeking places to their liking along the shore line. This place may be a shaded spot caused by a lily pad. The place not being large enough for all the school, many times

they will mass together, all apparently trying to occupy the same spot at the same time, until there is danger of the weaker ones being suffocated. The watchful parents, noting this, crowd them-



THE COMMON BULLHEAD

The Bullhead is a representative of our night or nocturnal feeders, and of those feeding among roily waters. The eyes are comparatively small, and in feeding, sight is probably supplemented by the barbels or whiskers around the snout. The Bullhead is scaleless and the skin is composed of a tough rubbery substance. The Dorsal and Pectoral Fins are armed with a single sharp spine, capable of inflicting severe cuts on the hands when handled.

selves into the school, and by upward motions of their bodies, scatter the youngsters in all directions.

The family by this time, having more or less confidence in themselves, resent this rough treatment and sometimes endeavor to leave home. If this happens to be the case, their minds are quickly changed, as the parent will pick up the runaway in its mouth and blow it back among its brothers with sufficient force to cause all thought of running away to leave its mind.

While the parents are very attentive to their young, willing, if necessary, to sacrifice their lives for their little one's protection, they nevertheless maintain rigid discipline in the family. If it becomes necessary to blow the little fish back among the school too often, the parent, apparently forgetting to blow it from the mouth, swallows it, thus ending forever the cares of the wayward one.

In about three weeks from the time the little fish first leave the hole, they will have doubled in size and will require a vast amount of food for their well-being; more than the parents can find for them when traveling in so large a school; hence the little fish will have to leave their parent's protection and shift for themselves. They break up in small groups and wander along the shore lines among the aquatic plant life.

HOW FISH LIVE

For convenience fish are classed under three heads, game fish, food fish, and forage fish.

Fish differ much in energy, courage, and resistance to attack. Those which possess all three attributes in a marked degree and are a fair size when fully grown, are termed game fish. They are prized and much sought after by the angler for the fight or struggle they afford when hooked. The brook trout, the black bass, the yellow perch, and the pike perch, are the most important game fish of Pennsylvania.

When angling for game fish, much wholesome recreative sport is afforded the fisherman; but fish not possessing qualities of gameness in so marked a degree are also sought; because from the time of primitive man, fish have been one of his staple foods.

Fish sought more for their eatable qualities than for their gameness, are known as food fish. In the inland waters of this state, it is unlawful to catch food fish other than with rod, hook, and line, but even by this means the number of pounds taken and consumed each year is enormous. Those of our inland food fish most sought after are the catfish, the sucker, the carp, and the eel.

Pennsylvania has a shore line on Lake Erie of approximately forty-five miles. Along this shore great industries are maintained by capturing with many kinds of devices, fish to be sold on the market as food.

The fish generally caught by these commercial fishermen are white fish, cisco, and blue pike; and these fish rightfully can be called the chief food fish of Pennsylvania, as they have very few game qualities and are rarely taken by hook and line.

The forage fish are also very important inhabitants of our inland waters. These fish, which rarely exceed six inches in length, usually belong to the minnow family and are commonly called bait fish. There are many varieties and they are adapted to living under all the conditions in which food fish and game fish exist. This is so that they may be used as food for the more desirable species, which eliminates to a certain extent the tendency of the more valuable fish to prey upon one another.

The inland waters of Pennsylvania consist of the cool mountain streams, the home of brook trout, brown trout, and of a number of kinds of minnows; the larger slow moving streams or rivers, the home of black bass, pike perch, yellow perch, suckers, bullheads, and a few other kinds of food fish and game fish, together with various kinds of minnows; and our natural lakes and our artificial ponds, the home of pickerel, lake trout, yellow perch, sunfish, bullheads, and minnows.

There can be no distinct line drawn between the fish of the rivers and those of the lakes, as fish that prefer the rivers, like the bass and the pike perch, are found in some of our lakes and our ponds. But where the ponds or the lakes are small and inhabited by such voracious fish as the bass and the pike, the fishing is meager. Because of their feeding habits, fish of this character require a large range.

Fish, such as yellow perch and bullheads, that prefer the ponds or the lakes, are also found thriving in our rivers. These pond fish, so to speak, living in the rivers, seek the eddies and the quiet waters where conditions are similar to those in the lakes or the ponds.

The chief food of our most important fish, from the angler's point of view, is other fish, and apparently nature intended a number of different kinds of fish to live together in the same body of water, regardless of the toll taken on the smaller ones by the larger individuals. In order that the smaller and less voracious varieties be given a chance, their habits are such that when fully grown the different kinds select different portions of the pond or the body of water they are in for a feeding ground. This different range of feeding ground has a tendency to keep the adult of the larger and more voracious species seeking their food in a different portion of the pond than that used by the adult of the smaller species.

The fish of a small lake or pond can be roughly divided into shore feeders, bottom feeders, nocturnal or night feeders, those feeding in comparatively deep water, and those feeding in extremely deep water.

Of the fish commonly found in our small inland lakes, the sunfish, a shore feeder, takes food both from the top and the bottom of the pond. The pickerel, a true shore feeder, eats other fish chiefly, and its feeding ground is along the shore line among the aquatic plants, which is the feeding place for many of the smaller fish of the lake. The sucker is a good representative of the bottom feeding variety. In an earlier chapter, we spoke of the forms of fish in relation to their feeding habits. By examining the mouth of the sucker with regard to its form and position, one can readily see that nature intended that he should seek his food on the bottom.

The bullhead is a representative of the nocturnal or night feeders, and a feeder in the roily waters where little light penetrates. The lake trout is a feeder of the very deep, cold portions of the body of water he inhabits, and he subsists chiefly upon smaller, more unfortunate fish that by chance enter his range. The yellow perch is a feeder midway between the very deep water feeders, like the lake trout, and the shore feeders, like the pickerel.

I have mentioned that the chief food of our principal adult fish is other fish, but no definite statement as to what constitutes the food of the many varieties found in our waters can be made. The food depends largely upon local conditions, as for example, the yellow perch will live mostly on insect and other small life, such as blood worms, and fresh water shrimp, where these abound; but when conditions are not favorable to insect growth, the yellow perch feed on other fish.

The age of the fish has a great deal to do with what constitutes its food. Roughly, the feeding stages of fish can be divided into three periods; first, the sac feeding stage; second, the plankton feeding stage; and third, the adult feeding stage.

The Sac Feeding Stage: When the fish first hatches or breaks from the shell of the egg, it has attached to the lower portion of its body a small sac commonly known as the yolk bag or food sac. The contents of this sac furnish the baby fish with nourishment during the early period of its life. The length of time that the baby fish feeds upon the food sac depends upon two things, the temperature of the water, and the kind of fish. When the water temperature is low, the absorption of the food in the sac will be less rapid than when the temperature is high.

Fish are known as cold-blooded animals, while higher animals are warm-blooded animals. A low temperature increases the activity of warm-blooded animals with the result that they require additional food. In cold-blooded animals the reverse exists. When the temperature is low they become sluggish and less active, with the result that they require less food for their well-being. This has much to do with the slow absorption of the yolk bag when the water temperature is low.

With different species of fish the length of time the baby fish feed from the food sac varies greatly. The brook trout feed upon the yolk bag from fifteen to thirty-five days. With the yellow perch the sac feeding stage is from seven to ten days.

The Plankton Feeding Stage: While the yolk bag is being absorbed, the little fish are growing and gaining in strength so that by the time it is entirely, or very nearly absorbed, they are able to swim about in search of food. The first food taken through the mouth of all baby fish is plankton. Plankton consists of plant

life and animal life of a very low form, ranging in size from that so small it cannot be seen without the aid of a microscope to that the size of a pin head; or in other words, plankton is the small floating or weakly swimming life of a body of water.

The exact time at which any species of fish changes from the plankton feeding stage to that of the adult feeding stage cannot be stated, as some species of fish live almost exclusively throughout life on these small organisms.

Adult Feeding Stage: Taking the adult fish as a whole, we find that their food consists of almost every kind of an organism living in and about the water. For convenience we will group their food under four heads.

Other Fish: The amount and the kind of food consumed depend much upon the season of the year; as an illustration, when crawfish are shedding their shells, they are the favorite food of the bass, but seasons of the year when the shell is hard, they are not eaten in so great a quantity. Again, at a season of the year when the gnats, the millers, and the moths are flying near the surface of the trout streams, the fish can be seen jumping for them, and they comprise the chief food of the trout for that period. But the food that can be found in the stomachs of our most important food fish and game fish at all seasons of the year is other fish.

Each moment of the day, fish are giving their lives in order that other fish may live. When food is scarce, most fish will divert to cannibalism. To guard against this, nature has provided food in the way of forage fish. These unfortunate little fish, were they not very prolific, or capable of depositing many eggs, would soon be exterminated, as many of them are provided with brilliant colors or shining sides in order that they can be more easily seen by the more fortunate ones.

The forage fish that nature intended to be in our waters as a food for other fish have been greatly reduced in numbers. This has been brought about by the unwise cutting of our timbers, by the pollution of the streams, by the introduction into our small lakes and our ponds of undesirable species of fish, such as bass and pike, and by the wholesale capture of the forage fish by the bait fishermen.

Through the efforts of the State Board of Fish Commissioners, much is being done to correct this condition, first, by passing laws

prohibiting the wholesale capture of these forage fish; and second, by propagating them at a number of the hatcheries for restocking the public waters.

Crustacea: The crustacea of our fresh water, so called from their crust-like shell, consist of a large and complex group of organisms that can be roughly divided into water fleas, scuds, and crawfish. These organisms are of many forms and sizes and are preyed upon by fish of all species regardless of their age or size.

Insects: The insects upon which fish feed comprise another large group, including the larvae in various stages of those insects that go through a period of transformation in the water, like the May fly, the nymph, the midge, the mosquito, and many others. The land insects eaten include almost all those found near the water; such as, the ants, the grasshoppers, the millers, the common house flies, many of which fall from the overhanging branches into the water.

Mollusks: The mollusks comprise our snails and our fresh water clams. The mature clams are not eaten to any great extent, but the young are readily taken by many fish, principally during the months of June and July, at which time they are about the size of BB shot, only, of course, of a different shape. Snails are eaten by many different kinds of fish but at certain seasons of the year they comprise the principal food for the sunfish, the yellow perch, and the bullheads.

Aquatic Vegetation : Very few of our fish consume any great amount of vegetable matter; but it plays such an important part with reference to fish life in a body of water that its various uses will be mentioned here.

Aquatic vegetation consists of many different varieties fitted to live under different climatic conditions. Some kinds thrive in still water, other kinds in swift water. The depth of water required for the different varieties ranges from many feet to a few inches. Some varieties live wholly submerged, others with the tops of the leaves exposed or floating on the surface of the water, and others with branches extending some distance out of the water.

Cycle of Food: Animals cannot organize food from inorganic substances, but use as food matter that which is already organized. Plants can and do organize inorganic substances into food, by changing during their growth and their decay certain salts taken from the

water and certain gases taken from the air and the water which are essential for the life and the growth of the planktonic organisms. These organisms in turn are food for the baby fish.

Many planktonic organisms feed directly upon vegetable matter. These vegetables contain minerals that are essential to the growth of some of the planktonic organisms, such as the daphnia in the formation of their calcium shells. From observation and experience over a number of years at the fish hatchery, I am led to believe that the mineral contained in the shells of these tiny organisms is necessary for the well-being of certain small fish, and as yet, no artificial food that will take the place of these organisms has been discovered. This is particularly true of the baby black bass.

Aerating Agent: In every body of water the decay of vegetable and animal matter is taking place. During this decomposition, certain gases (carbon dioxide and others) are thrown off. Through the respiration of aquatic animals, similar gases are thrown off. If there were no purifying agents in the water, the animals would soon become so saturated with these obnoxious gases that they could not exist. The aquatic plants in their growth absorb the carbon dioxide and, in turn, throw off as a waste product, oxygen, which is essential to the respiration of the fish and the other animals of the water. Thus it can be seen that the gases thrown off as a waste product by the plants are essential for the well-being of the fish, and the waste products thrown off by the respiration of the fish and the other animals are taken up by the growing plants.

In a body of water such as a trout stream, or a river where the water is flowing over falls, rocks, etc., plants do not play a very great part as aerating agents, nor do they in larger bodies of water, such as lakes, where the waters are lashed or given movement by the wind. However, in still bays and in small bodies of water which are subject to extreme summer heat and to long continued spells of calm, the aquatic plants are the chief aerating agents over these periods, and many times are the means of saving fish from suffocation.

Protection: During the early life of many fish, the dense growth of aquatic plants is sought as a place of protection from larger fish and other enemies. Among the dense growth of submerged plants, the little fish have a chance of escaping the larger ones by darting

rapidly through the foliage of their aquatic gardens. Plants, such as the water lilies, which have large floating leaves, are a great protection to fish of all sizes from fish-eating birds. This same type of plant also affords excellent shade for the fish from the direct sun rays.

A Base for Attachment of Eggs and Lower Plant Life: Some fish attach their eggs to aquatic plants where they are supported during the period of incubation. Many of the insects which serve as food for the fish also use the plants as a place to lodge their eggs during incubation. A number of the insects after hatching from the eggs remain on the plants during periods of transformation, and are utilized by the fish as food. Bodies of water not containing aquatic plants are shunned by these winged insects, as they seek out bodies having conditions favorable for their reproduction. Thus the fish in the barren waters are deprived of an important food supply.

There are a number of forms of lower life that are not free swimmers, such as, various kinds of algae, and these must have some sort of support in order to exist. Plant life affords support for these organisms. While these lower forms may not appear necessary to a body of water with reference to fish life, they are all organizers of fish food; and let us bear in mind that any body of water can support fish life only in proportion to the amount of food contained therein.

Enemies of Fish: The chief object in the life of any animal is to leave another of its kind in its place when it dies; and in order to do this, it must have a range where it can secure food, have conditions favorable for reproduction, and for the growth of the offspring until it is of an age where it is self-dependent.

Apparently, in fish life before man's interference, nature kept a nicely adjusted balance. Even though fish were preyed upon by many enemies, principally other fish and fish-eating land animals, the streams, the rivers, and the lakes were teeming with fish. One reason that fish were able to survive in great numbers was because of their remarkable range of fecundity or productiveness.

It appears that nature intended, that for every species, the number of offspring, be sufficient to meet the losses to which the species was liable. Without a doubt, before the interference of civilized man, the greatest enemy of fish was other fish, and as an example of the range of fecundity in relation to the enemy (other fish) preying upon

their offspring, we will take the fish commonly found in many of our small lakes by the early settlers; namely, the pickerel, the yellow perch, the golden shiner, and the bullhead.

In the spring of the year the pickerel are the first to spawn. As fish go, the pickerel are not very productive, an average sized female producing but a few thousand eggs. It is not necessary that they be so, as the eggs are generally deposited before the ice leaves the body of water, thus eliminating, to a certain extent, injury caused to the eggs by wave motion and by sediment. The ice is also a protection to the eggs from land animals preying upon them. The period of incubation is short, and with the water at a low temperature not many spawn-eating aquatics feed upon them, as most fish and other aquatic animals consume very little food during the winter months, or before the water reaches a certain temperature in the spring. The pickerel, being the first fish to hatch, and growing very rapidly for the first few months, are not preyed upon by any other fish of the same year's hatch.

The yellow perch are the next to spawn. The ice has now left the body of water, and aquatics are beginning to feed. The eggs will be preyed upon by spawn-eating animals, both terrestial and aquatic, and the baby yellow perch will be the chief food of the baby pickerel for a certain period. To offset these losses the yellow perch are very fecund; a single female depositing from twenty thousand to forty thousand eggs.

The next to reproduce will be the golden shiner, a forage fish. The offspring of these unfortunates, because of their attractive appearance and their readily digestible character, will be preyed upon during the entire season by the baby pickerel and the baby perch, and a sufficient number must escape to furnish the chief fish diet for the adult inhabitants and still not be exterminated. For this reason, although they rarely exceed six inches in length when matured, they reach sexual maturity at an early age and are very fecund.

The bullhead will be the last of the group to spawn, but because of the wonderful parental protection afforded the eggs and the baby fish, which was explained in a preceding chapter, they need not be so productive. A female deposits only a few thousand eggs.

As conditions are today the enemies of fish can be classed under two heads; namely, artificial and natural enemies.

Artificial Enemies: Man has created the artificial enemies of fish by pollution or the emptying of substances that are detrimental to fish life, and to the organisms and the plants that indirectly furnish food for the fish, into our streams and our lakes; and by the unwise cutting of the timber, which causes the fish and the fish eggs to be subject to frequent floods, droughts, and sudden changes of temperature. The excessive amount of sediment washed in from the surrounding hillsides during times of floods is most destructive to fish life and to insect life, and the streams are depleted by too much fishing.

Rod, hook, and line fishing has increased by leaps and bounds in the last ten years. This is due principally to the automobile and to increased population. The ease with which streams and lakes can be reached has induced many people to go fishing who never indulged in the sport before.

The refrigerator system and modern transportation have enabled the commecial fishermen of the great lakes to ship their products in a fresh condition to all parts of the country. The delivery of these fresh products to the inland markets has created a demand that has led the commercial fishermen, assisted by all sorts of modern tackle for the capture of these great schools of fish, to exert every effort to supply the demand.

The worthwhile catches of these fish take place as they are moving in great schools to the spawning beds, and, unfortunately, they are captured and sold in the market before they have a chance to reproduce. This condition is offset somewhat by the artificial propagation of this important food supply by the Federal Government, by the various states bordering on Lake Erie, and by the Canadian Government.

Natural Enemies: The natural enemies of fish can be classed under five groups: other fish, reptiles, birds, amphibia, and disease.

Other Fish: Fish in devouring one another as food are enemies to each other, but perhaps the worst enemy is the fish that feeds upon the eggs of other fish. The worst of the spawn-eating fish, to my knowledge, are the carp, the common eel, and the lamprey eel, although science tells us that the lamprey eel is not a fish.

The spawning habits of the eel have been somewhat a mystery for generations, and frequently letters of inquiry are received by the

Board of Fish Commissioners in reference to the spawning habits of this peculiar fish. A few years ago a man wrote to the Board of Fish Commissioners that he was catching eels inside of which he discovered spawn which he thought to be the eggs of the eel. He sent a number of specimens to the Board of Fish Commissioners, and upon examination, it was found that the eels had been gorging themselves upon yellow perch spawn. Had he been a close observer of nature, he would have readily seen that had this been true spawn of the eel, it would not have been found in the digestive tract.

Reptiles: The reptiles that prey upon fish are water snakes and turtles. Water snakes are clever fishermen, and during the summer months can frequently be seen swimming along the shore line with fish protruding from their mouths. In my observation over a period of three years, in a pond containing bass, pickerel, yellow perch, bullheads, and golden shiners the water snakes were seen to be feeding principally upon small bullheads. Why the bullheads were the chief food I am unable to say, other than perhaps because they were the most easily captured.

The turtles, principally the snapping turtles, are another set of crafty fishermen. These creatures when feeding lie quietly on the pond bottom where the shell has the appearance of a moss-covered rock. As an unsuspecting fish swims by, it is easily captured by the lightening-like flash of the turtle's head and neck.

Birds: Although a large percentage of our native birds build their homes, feed, and live about the water, only a few of them are fish eaters. Those most commonly encountered or seen in the act of destroying fish, are certain species of ducks, the fish hawk or osprey, the heron, the bittern, and the king fisher. Just how destructive these birds are to our wild life is probably not known, but I do know that at the fish hatchery, where large numbers of fish are confined in small areas, many of them fall a prey to the king fishers and the fish hawks.

Amphibia: Of this order which includes our toads, our frogs, and our salamanders, perhaps few can be called destructive to fish life with the exception of the newts and the mud puppies. I have never seen newts in the act of eating live fish, but these little creatures are ravenous spawn-eaters. The mud puppies, of which there are but a few, fortunately, in the waters of Pennsylvania, eat both fish and spawn.

Disease: Fish, like all higher forms of life, are subject to various kinds of disease. Sometimes these take on the character of an epidemic and before it is checked, or runs its course, the loss of fish is so great the species in a body of water is nearly exterminated.

In the early days, or when the streams were in their natural state, if these diseases existed, they probably were not of so serious a nature as they are today, when fish are living under more or less unnatural surroundings. These unnatural conditions have greatly lowered the resisting powers of the fish, and they are unable to throw off the disease germs. This was not the case before conditions were interfered with by man.

Relationship to Man: The early settlers built their homes by the waterside. History shows us that most of the early inland settlements were on the banks of our large rivers. This was done because at this early period the rivers, the lakes, and the streams always afforded the settlers a most dependable supply of wholesome food in the form of fish, and much of their clothing was made of the skins of animals found about the watersides. The rivers were their highways; the streams and the lakes, most of which were navigable for their light crafts, formed a network of communication between the settlements.

Different circumstances in modern times have necessitated that the population seek elsewhere for most of their food supply. From this have evolved our modern farms, our industries for the manufacture of clothing and other necessities, and our modern fishing industries, such as those carried on at Lake Erie, where the fish are packed for transporting great distances. But in spite of all these modern methods of living, a longing for the waterside still remains; and when circumstances permit, hither do we go for rest and recreation, and the places most sought are those affording the best fishing.

Fish constitute a group of animals that are nearly always beneficial to man. The recreative sport of angling cannot be figured in dollars and cents; but from a standpoint of food supply, thousands of pounds of this wholesome and nutritious food are taken from our public waters each year.

The annual catch of food fish by Lake Erie fishermen from Pennsylvania amounts to approximately eighteen million pounds. A mov-

ing picture film, produced by the Board of Fish Commissioners, and entitled "Pennsylvania's Fishing Industry on Lake Erie," portrays clearly this enormous industry and shows how the artificial propagation of fish helps to maintain it. This film can be obtained by public institutions, sportsmen's associations and similar organizations by making application to the Board of Fish Commissioners, Harrisburg, Pennsylvania.

ARTIFICIAL PROPAGATION

In recognition of the economic value of fish, both from the standpoint of food and of recreation, the Federal Government, many of the States, and a number of the foreign countries, have appointed commissions for the study of problems connected with the fisheries and for their better regulation. This has become necessary because of the drain put upon this food supply by modern civilization.

In Pennsylvania, all matters pertaining to fish and fishing come under the jurisdiction of a Board of Fish Commissioners, composed of a president, or chief executive, known as the Commissioner of Fisheries, and seven other citizens, known as Fish Commissioners, whose headquarters are Harrisburg, Pennsylvania.

One of the many duties of this Board is the establishment and the maintenance of institutions known as fish hatcheries. At these institutions fish are artificially hatched and reared for liberating in our public waters. This is done to help offset the checks upon their natural growth and their reproduction by civilization.

In about 1873 Pennsylvania established its first fish hatchery at Donegal Springs, Lancaster County, Pennsylvania. At this time, fish culture was only in its experimental stage; but from this small experimental station, through the efforts of practical men who have chosen as their life's work the fish cultural problems of Pennsylvania, six modern fish hatcheries and a program of ten additional ones have evolved. Through the efforts of men such as these, in this short period, wonderful progress has been made in the artificial propagation and rearing of fish, as well as in the transportation of fish and of eggs, until at the present time, the artificial propagation of many species is no longer in the experimental stage.

Today, the fish hatcheries of Pennsylvania are much more than the name implies, and could rightly be called fish farms. In the early days of these institutions they were simply fish hatcheries, as the eggs were collected from the wild fish, artificially hatched at the hatcheries, and the very young fish released in the streams or the lakes. This is not the case today. The egg crop, with the exception of the eggs obtained from the food fish of Lake Erie and the pike perch of our inland waters, is obtained from brood fish kept at the hatcheries for this purpose; and most of the fish are reared to a size which enables them to take care of themselves when released in the public waters. The rearing of fish to a larger size naturally necessitated the reconstruction and the enlargement of the hatcheries, and the size of the fish released has gradually increased until in some species, it is the legal catching size.

In the early days of the hatcheries, the planting of baby fish was a necessity, as no way was known for holding great numbers of these babies in captivity for any length of time. Probably, much good was done by releasing fish of a small size, as in those days many of our streams and our lakes were in a more or less natural state and could well act as nursery sites for the baby fish; but in recent years, through industries and through too much fishing, conditions have become such that our public waters can no longer act as nurseries. For the results desired, the fish must be reared artificially at the hatcheries until they are of an age at which they have a fighting chance against the many existing unnatural conditions. At the hatcheries in Pennsylvania are propagated practically all species of food fish and game fish of worthwhile qualities that are found in our public waters, together with a number of forage fish. The food fish and the game fish are brook trout, brown trout, black bass, sunfish, pike perch, catfish, yellow perch, blue pike, white fish and cisco. The forage fish reared are a number of species of minnows.

For convenience, these fish are classed in two groups, cold-water species, which are the fish commonly found in our cold mountain streams as the brook and the brown trout; and the warm-water species, or those found in our lakes, our larger streams and our rivers.

The hatchery superintendents, or the men in charge of the fish hatcheries, must be very keen observers of nature, because no two

of the many different species hatched and reared at these plants can be handled alike. This means that for the successful operation of the hatcheries, the men must be well-informed as to the habits of each species with reference to how they live, reproduce, and feed when living under natural conditions.

In the artificial rearing of fish, nature is imitated as much as possible. As an example, fish, such as the bullhead, that are by choice fish from ponds having soft, muddy bottoms, when in the wild state, are placed in ponds of this character at the hatcheries. Fish, like the trout, requiring an abundant flow of cool spring water in their natural habitat, must be surrounded by the same conditions when artificially reared.

This also holds true with the artificial incubation of the egg. Fish eggs that require a wave movement for their well-being when hatched naturally, must be given practically the same motion when hatched artificially. Those requiring no movement must be permitted to remain quiet in the artificial hatching devices. Thus it can be seen that if the men in charge were not perfectly familiar with the habits of the wild fish, they could not successfully imitate their mode of life under artificial conditions.

Methods Used in Securing the Fish Eggs: The brood fish with the exception of a few species, are confined in artificial ponds, year after year, for the purpose of producing the all-impotant egg supply. The size and the type of pond used for retaining the parent fish depend much upon the species with reference to their natural habits.

The parent trout are retained in ponds of comparatively small area, from one quarter of an acre to one and one-half acres, and are given an abundant supply of cool spring water. Many of the warm-water fishes require a much larger range where conditions are more natural and, consequently, more to their liking. This is particularly true of the black bass and the yellow perch. The ponds where these brood fish are retained range in area from one and one-half acres to one hundred acres.

The only fish of our inland waters propagated at the hatcheries the brood fish of which are not kept under artificial conditions are the pike perch. For the well-being of these voracious fish, a very large range of feeding ground and an abundant supply of their natural food are required. The range must be much larger than that which

would be practical to maintain at most fish hatcheries; for this reason, the eggs are collected from the wild fish, and then are artificially hatched at the hatcheries.

The eggs from our Lake Erie commercial food fish are also obtained from the wild fish. This is done as a strictly conservation measure. If the methods employed for the collection of the eggs were not used, millions upon millions of the unfertile eggs would be thrown away with the waste portions of the fish when they are dressed for the market. The following will show why this is so:

The commercial fishermen, moving in upon the spawning beds, make their important catches when the fish are collected in great schools. The capture is made before the fish have an opportunity to spawn. By capturing these fish in such great numbers before reproduction takes place, we are interfering with the great natural law

EXTRUDING THE EGGS OF THE FEMALE TROUT

EXTRUDING THE MILT OF THE MALE TROUT

of the propagation of the species. To eliminate the waste of this food supply, the Board of Fish Commissioners details men known as spawntakers to go on the fishing boats with the fishermen.

It is the duty of these men to take the eggs from the female as the fish are brought on board from the nets, before they die or are killed by the commercial fishermen, and fertilize them. When the boat reaches the dock, the eggs are taken to the hatcheries where they are artificially hatched. Later the baby fish are released in the open waters where a large portion of them survive. Thus the commercial fishing industry is preserved.

Fish eggs for artificial incubation are secured by different methods, depending upon the species. The method of artificial extrusion and fertilization is used in securing the eggs of brook trout, brown trout, pike perch, white fish, cisco, blue pike, and several kinds of minnows.

The brood fish are confined at the hatcheries, and at the approach of and during the spawning season, the females are examined every few days to determine their condition as to ripeness, or in other words, to find out if they are ready to give forth their eggs. This condition is told by the sense of touch of the attendants. Generally, when fish are ready to give forth their eggs, their abdominal walls will be soft and pliable to the touch. When they are in this condition, the eggs are squeezed from them by exerting with the hands a gentle pressure, beginning well forward and moving along the ventral surface towards the tail.

After the eggs have been extruded from the female, by manipulating the male in the same manner, the milt is poured over the eggs. When the milt or spermatozoa come in contact with the eggs, fertilization takes place. The fertilized ova are then transferred to the artificial hatching devices or incubators.

Artificial extrusion of the eggs of some species of fish is not practical. When this is the case, as with the yellow perch, the parent fish are permitted to deposit their eggs in the natural way on artificially constructed spawning beds. The eggs are then collected from these beds and are transferred to the artificial hatching devices.

In the case of some species of fish, as the sunfish and the bass, neither the artificial extrusion, nor the collection of the eggs from the spawning beds is practical. This is because of the peculiar spawning habits of these species and of the adhesive or sticky quality of the eggs. When this is the case, at the approach of spawning, the parent fish are confined in ponds where the conditions can be made as natural as possible for their reproduction. The parents are then permitted to build their homes or nests, to deposit their eggs therein, and to care for them and the very young fish in their own way. When the fry or the baby fish no longer require the parental protection, the adult and the young are separated and the babies are put into nursery ponds where they can receive the food and the attention they require.

Artificial Methods Used in Hatching the Eggs: At the hatcheries the eggs are hatched by either of two methods. The battery method is used to hatch fish eggs that require motion, like the eggs of the yellow perch, the pike perch, the white fish, the cisco, the blue pike, and of a few species of minnows. The trough method

is used where the eggs require very little, if any, movement. This method is necessary for the hatching of the brook and the brown trout.

In the above paragraphs, I have frequently alluded to the artificial hatching devices as incubators. To the practical fish culturist they are not known by this term, but are called the hatching battery and the hatching troughs. By the use of the term incubator, the reader must not conceive the idea that any artificial heat is used. The water in both systems is of its natural temperature.

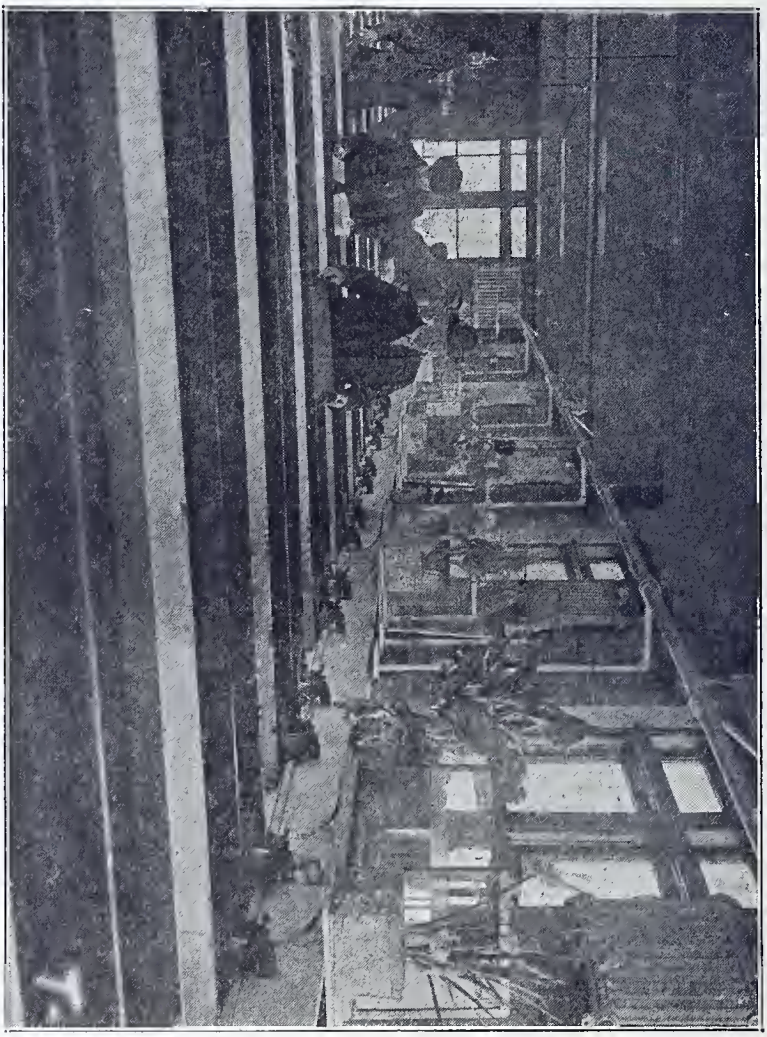
A hatching battery consists of a number of parallel troughs placed one above the other with an intervening space of about four inches between each trough. The troughs are arranged in tiers, the height and the length depending upon the number of jars to be used. While the battery is in use, water is kept running through the series. The water intake is at one end of the top trough and flows from one trough to the other until the bottom trough is reached; thence the water is conducted into the fish storage tanks. About every twelve inches in the series of troughs, a one-half inch spigot is placed. Below each spigot and resting on the next trough is a small shelf. On this shelf directly under each spigot is placed a glass hatching jar.

The hatching jar is a cylindrical glass jar fourteen inches high and six inches in diameter. The bottom of the jar is rounded in such a manner that the water striking the center of the bottom is distributed equally in all directions in an upward.current.

The overflow is at the top of the jar and the water is fed through an inserted glass tube extending from the spigot to within about one-half inch of the bottom. By this arrangement, when the eggs are placed in these containers, the upward lift of the water has a tendency to keep the eggs in a constant rolling motion. The battery process is simply an imitation of nature's way of caring for the eggs, the commotion in the jar replacing the wave action in the lake or pond.

The hatching troughs consist of a series of troughs fourteen feet long, eighteen inches wide, and eight inches deep with a depth of approximately four inches of water in each trough. The eggs are placed on wire trays and are submerged to a depth of several

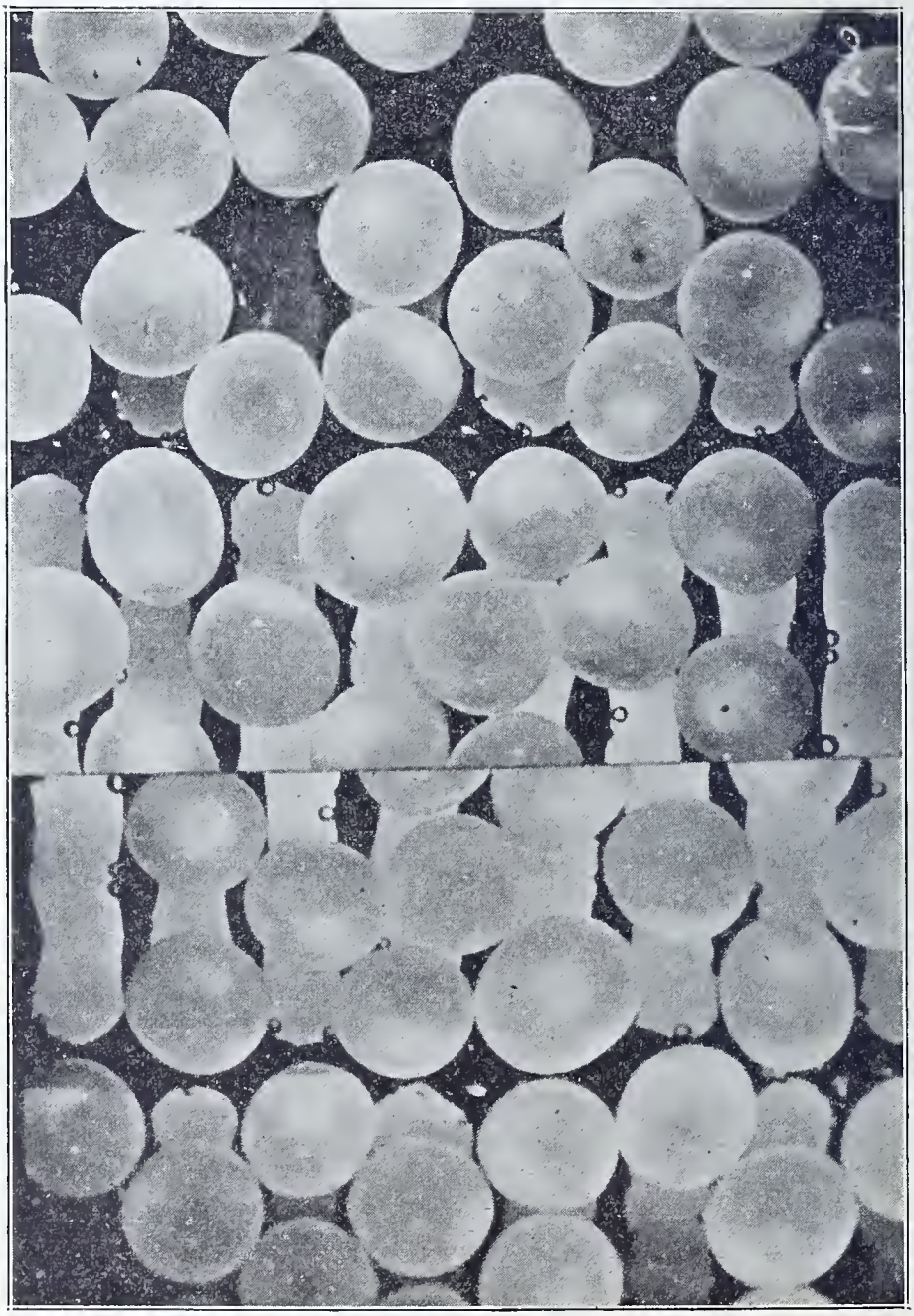
inches in the troughs of running water. This is again an imitation of nature's way of caring for the eggs that require very little, if any movement.



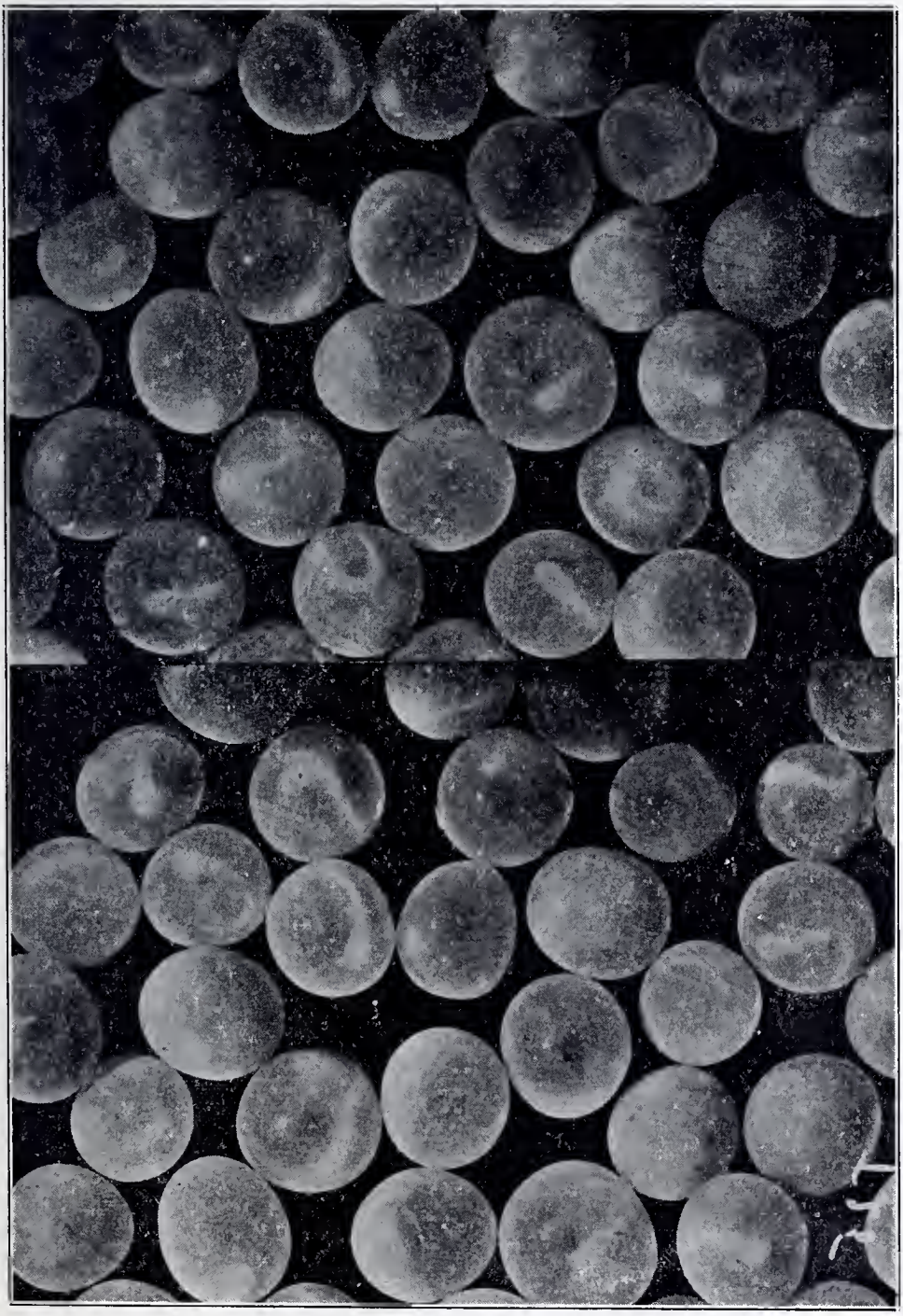
A Section of the Hatching Troughs in the Wayne Hatchery, Pleasant Mount, used in the Artificial Hatching of the Brook and the Brown Trout.

The Care of the Eggs and the Fish: During the period of incubation, fish eggs go through a number of stages of development which can plainly be seen with the unaided eye. For practical purposes, the fish culturist divided the periods of development into three stages, of which the first is the green stage. This is the period when no trace of life can be noticed. The second period

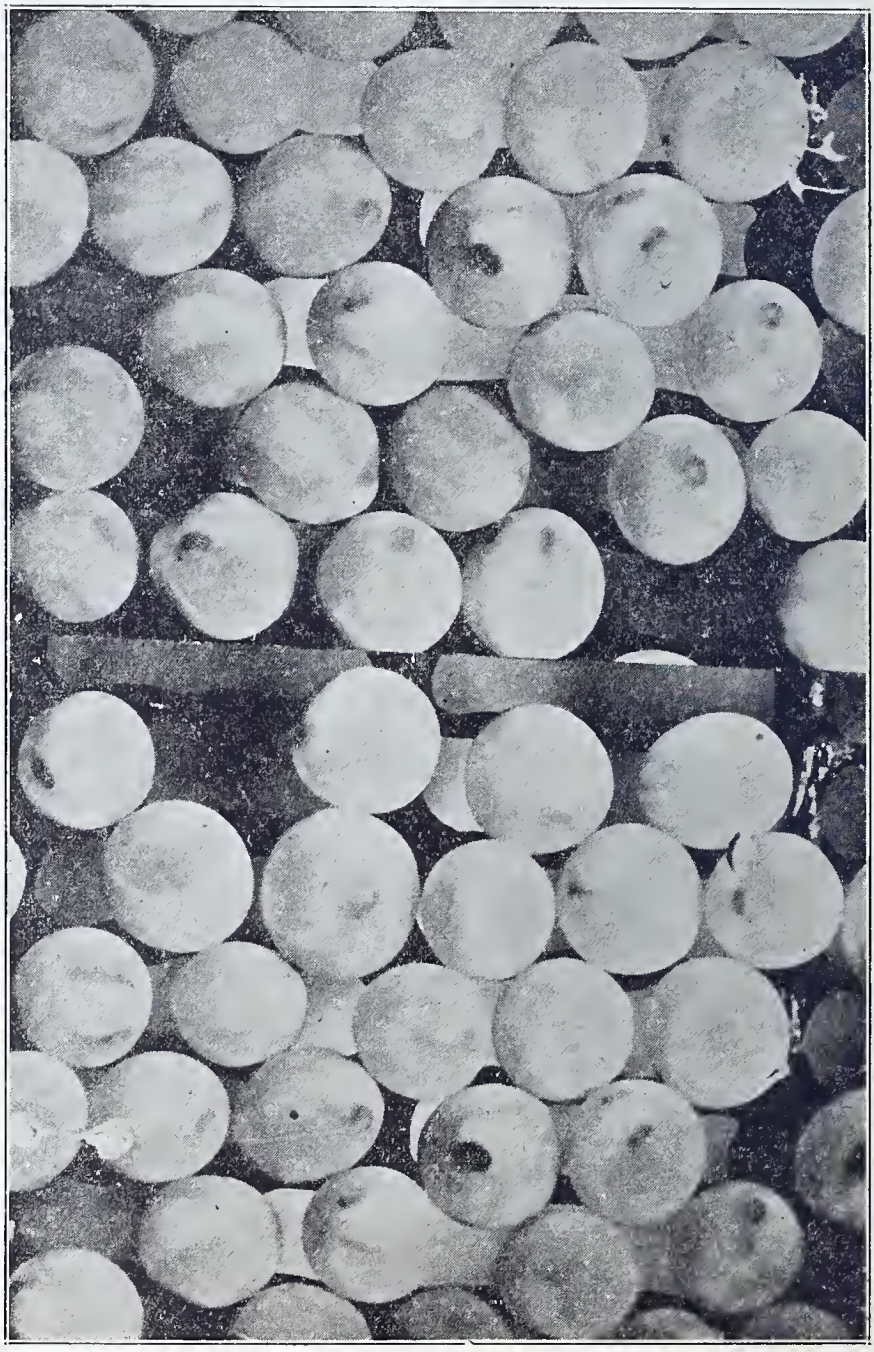
A Section of one of the Hatching Batteries in the Erie Hatchery, Erie, Pennsylvania.



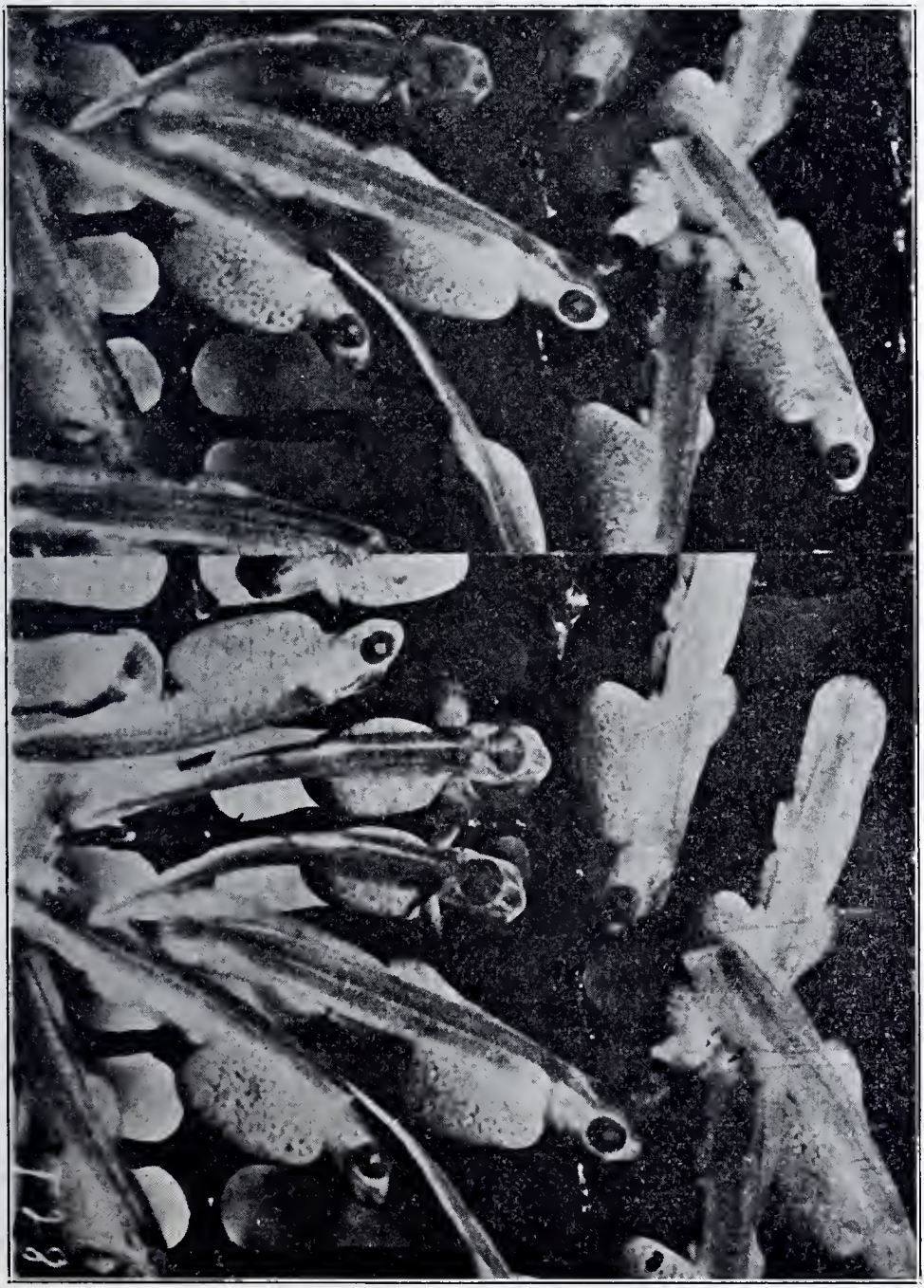
No. 1 Brook Trout Eggs, Green Stage



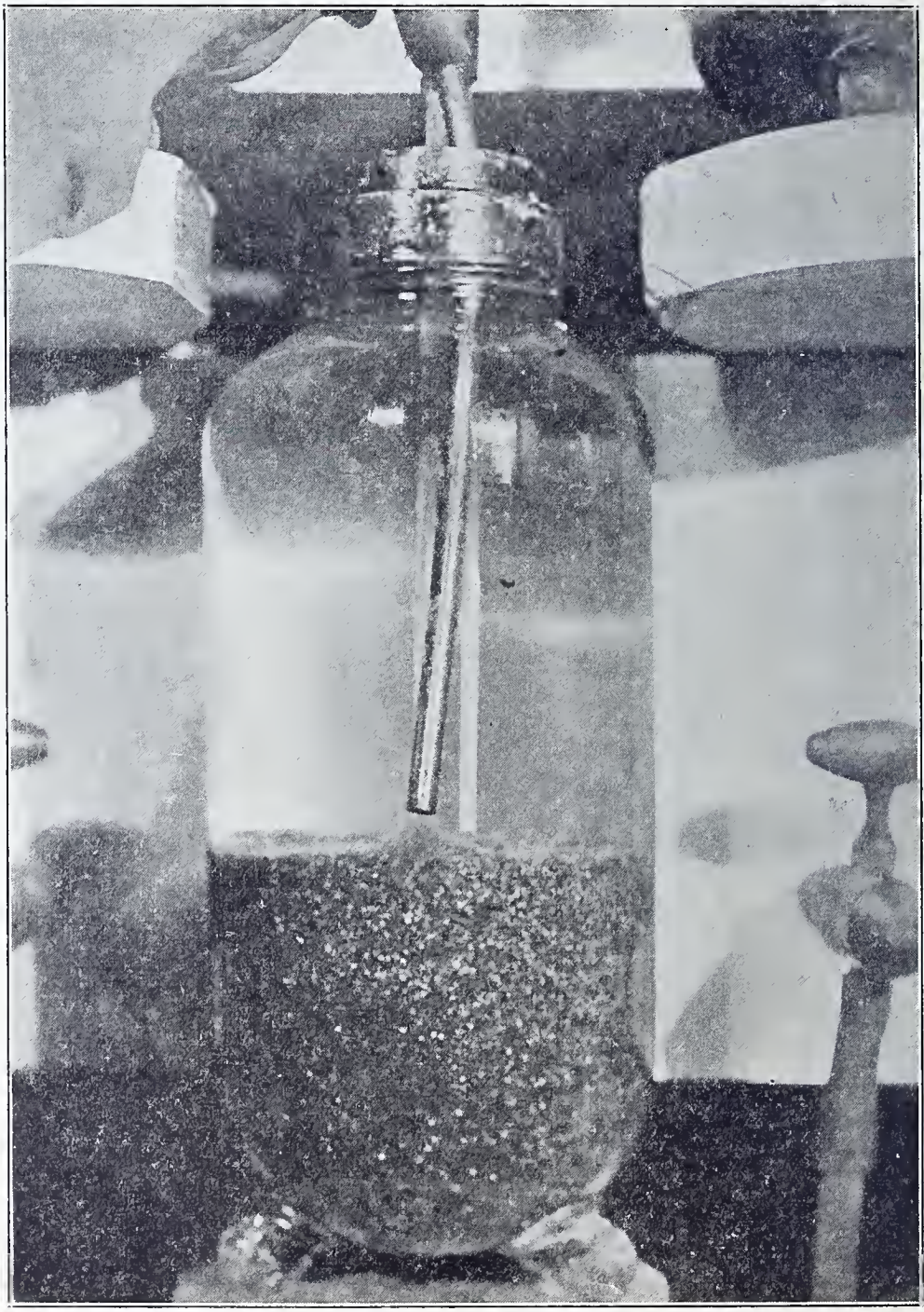
No. 2 Brook Trout Eggs, Tender Stage



No. 3 Brook Trout Eggs, Eyed Stage



No. 4 Baby Brook Trout Showing the Umbilical or Food Sac

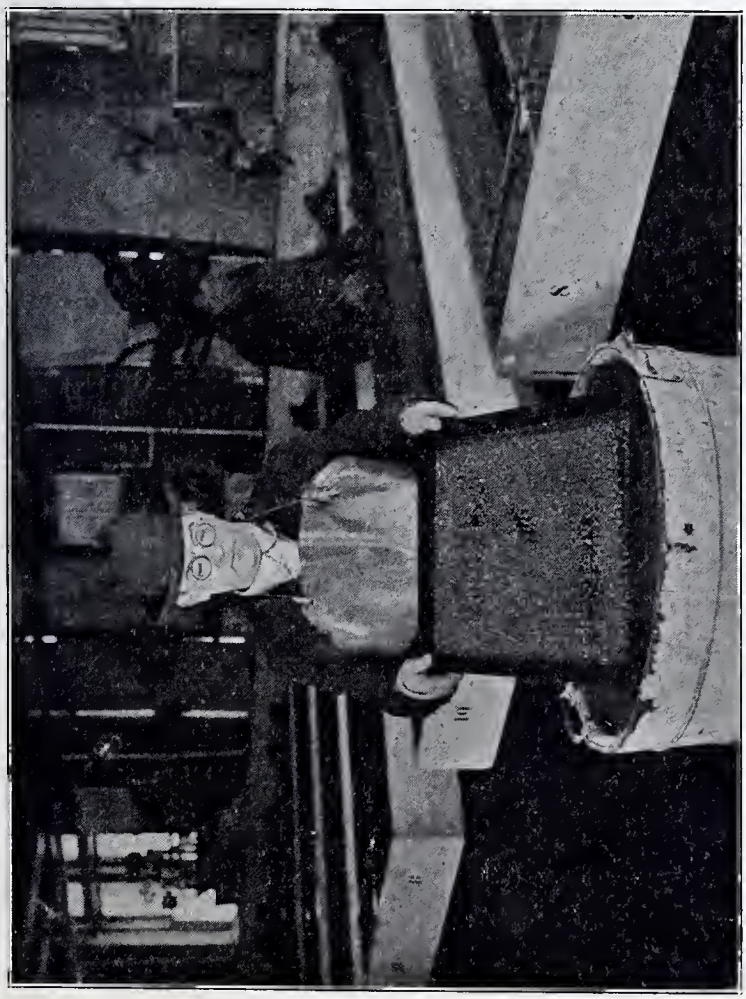


A Hatching Jar Containing Cisco Eggs

is termed the tender stage and is the time when the first faint form of the baby fish can be seen within the translucent shell. The third is the eyed stage when the distinct outline of the baby fish is plainly visible.

A number of different stages of the development of the brook trout egg can be seen by referring to the cut on the opposite page.

All during the period of incubation the eggs require the constant attention of trained men. The unfertile eggs, which turn white



A Tray of Brock Trout Eggs

from time to time, must be frequently removed to prevent contaminating the mass of good eggs. Excessive sediment must be removed to prevent smothering. When using the battery system, care must

be taken to keep every egg in constant motion, and yet to guard against a motion that would be too rapid and would result in injury to the egg. In the trough system, at certain stages of development, the position of the eggs must be changed, from time to time, to promote the healthy growth of the embryo.

During the period at which the fish are at the hatchery, they must have the same constant care as that given the eggs. The water supply must be regulated in volume according to the kind of fish contained in the pond. To prevent disease, conditions must be kept sanitary. This is done by frequently removing all foreign matter and dead fish, and at intervals the ponds are cleaned and sterilized. The fish must be given the kind of food best adapted for the well-being of each species, and generally for the success of the artificial propagation and rearing of the warm water species, the environment must be made as natural as possible.

When the baby fish first break from the shells of the eggs, they have attached to the lower portions of their bodies umbilical or food sacs. These sacs furnish the baby fish with food for a short period. The length of time they are nourished from the food sac depends upon the kind of fish and to some extent upon the temperature of the water. After the sac is absorbed, or very nearly so, these delicate creatures must be furnished other nourishment.

In some species like the trout and the catfish, the first food in this early feeding stage consists of finely crushed sheep's liver and of clabbered cow's milk. Other fish, because they are too small to consume any artificial food, or because it does not meet with their requirements, in the early feeding stage, subsist on plankton. Planktonic foods are required for the well-being of such fish as the baby pike perch, the baby sunfish, and the baby bass.

When the diet is changed to the food of the adults, not all fish can be fed upon the same food. The principal food of trout, sunfish, yellow perch, and catfish during their stay at the hatchery is meat. The meat used for this purpose consists generally of the heart, the liver, and the lights of the sheep. It is chopped or ground into fine particles, the size depending upon the kind and the size of the fish consuming it.

No artificial food upon which the bass and the pickerel will thrive has been discovered; and after they leave the plankton feeding stage,

they are given practically the same food upon which they would feed if they were in a wild state.

This natural food consists chiefly of forage fish. These forage fish are reared in ponds set aside for this purpose. It requires the same painstaking effort on the part of the hatchery superintendent to rear the large number of forage fish required for this purpose, as it does to rear the food and the game fish. The number of this species of fish for distribution each year depends indirectly upon the crop of forage fish. If success is not attained in propagating the forage, only a limited number of fish feeding upon it can be reared.

How Fish are Transported to the Public Waters: The length of time fish are retained at the hatcheries before they are released in the public waters depends a great deal upon the species, but generally such fish as the bass, the sunfish, the catfish, and a portion of the yellow perch are retained until they are from one and one-half to six inches long. All trout are retained until they are over four inches in length, and many of them until they are over the legal catching size of six inches.

When they are ready for planting they are conveyed by motor trucks and railroad trains to the public waters in cans similar to the common forty quart milk cans.

In an early chapter, we learned that fish require oxygen for their respiration, and that this oxygen is taken from the water. Where many fish are confined in one forty quart can, if unattended, they soon consume the supply of oxygen, and are suffocated. To guard against this, attendants or messengers accompany each consignment of fish from the hatchery to its destination. When the fish show signs of distress, the attendants aerate the water in the cans by a dipping process. This dipping process consists of dipping the water from the can and pouring it back from some height. As the water is poured from the dipper and strikes the water in the can, the aerating process is much the same as water running over rocks, falls, etc.

Location of the Hatcheries of Pennsylvania and Kinds of Fish Reared.

The Corry Hatchery, located at Corry, Erie County, is devoted to the propagation of brook trout.

The Erie Hatchery, located at Erie, Pennsylvania, is used to help maintain fishing in Lake Erie by stocking the lake with such fish as is commonly fished for, as white fish, cisco, blue pike, yellow pike, pike perch; and in addition to this, propagates yellow perch and pike perch for distribution in our inland waters.

At the Bellefonte Hatchery, Bellefonte, Center County, are reared brook trout and brown trout.

At the Union City Hatchery, Union City, Erie County, are reared yellow perch, pike perch, sunfish, and catfish.

At the Torresdale Hatchery, Torresdale, Philadelphia, are reared yellow perch, pike perch, sunfish, catfish, and minnows. At this plant much effort is devoted to the propagation of minnows used for stocking our public waters.

The Wayne Hatchery, Pleasant Mount, Wayne County, is a combination hatchery, devoted to the propagation of both the trout and the warm-water species. The warm-water species include the yellow perch, the pike perch, the black bass, the sunfish, and the minnow. While a portion of the minnows propagated is sent out for stocking purposes, the major portion of them is consumed by the fish retained at the hatchery.

Conclusion: The fish hatcheries of Pennsylvania, taken as a group, are the most modern of any institutions of their kind in existence today. While it is possible in this pamphlet to touch but slightly upon their operations and maintenance, these plants are open to visitors daily; and to those uninformed but interested in fish culture, the hatcheries contain a fund of information they little dreamed existed.